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Planning for offshore CO2 storage: Law and policy in the United Kingdom

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Abstract

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Keywords

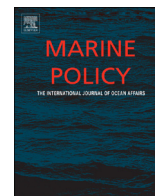
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Planning for offshore CO₂ storage: Law and policy in the United Kingdom

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ABSTRACT

'Offshore CO₂ storage' refers to the injection of liquefied CO₂ into deep geological formations beneath the seabed (e.g. depleted oil and gas reservoirs, and saline aquifers) for the purpose of storing it there on a permanent basis. The storage in this manner of captured CO₂ emissions from industrial installations and power plants has attracted considerable scientific and technical interest as a potential mitigation response to climate change. A key issue facing policymakers in several countries is how to reconcile policy commitments to develop offshore CO₂ storage with other competing – and potentially conflicting – uses of the marine environment. With a view to informing policy responses to this issue, this paper presents a case study of legal and policy frameworks concerning offshore CO₂ storage in United Kingdom. The paper maps key design features of the United Kingdom's framework for marine permitting and planning, appraising the extent to which they enable orderly development of offshore CO₂ storage in a manner consistent with relevant high-level policy objectives.

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1. Introduction

'Offshore CO₂ storage' refers to the injection of liquefied CO₂ into deep geological formations beneath the seabed (e.g. depleted oil and gas reservoirs, and saline aquifers) for the purpose of storing it there on a permanent basis [1]. The storage in this manner of captured CO₂ emissions from industrial installations and power plants has attracted considerable scientific and technical interest as a potential mitigation response to climate change [2]. Carbon capture, transport and storage (CCS) is politically well-favoured in several countries and is a prominent feature of several national, regional and international climate-related policy strategies [3]. It has also attracted vehement criticism, in particular from locally-based community activists and certain environmental NGOs [4]. Proponents of CCS commonly cite the technology's potential to reduce net CO₂ emissions arising from fossil fuel combustion [5], which for several decades is likely to remain the primary means of meeting global energy demand [6]. Criticisms of CCS commonly emphasise: technical difficulties and economic costs of developing the technology; the potential of CCS to maintain and encourage unsustainable consumption of fossil fuels, in addition to associated health, safety and environmental risks (e.g. the risk of environmental damage caused by leakage of captured CO₂ from storage sites) [7].

Despite these criticisms, in several countries there remains an ongoing political commitment to support development of offshore CO₂ storage as part of a broader goal to reduce CO₂ emissions through commercial deployment of CCS. The United Kingdom (UK)¹ Government has for example announced GBP 1 billion of capital funding to support commercial-scale CCS demonstration projects with a view to enabling commercial deployment of the technology 'in the 2020s' [8]. This funding covers only CCS projects that transport captured CO₂ to storage sites located offshore [8].

A key issue facing policymakers in the UK and other interested countries is how to reconcile development of offshore CO₂ storage with other competing – and potentially conflicting – uses of the marine environment. With a view to informing policy responses to this issue, the present paper reviews legal and policy frameworks applicable to offshore CO₂ storage undertaken within the UK's maritime zones of national jurisdiction.² In particular, the paper identifies key design features of the UK's frameworks for marine permitting and planning, appraising the extent to which they enable orderly development of offshore CO₂ storage in a manner consistent with the high-level policy objective to achieve commercial deployment of CCS in the 2020s.

¹ For the purposes of this paper the term 'United Kingdom' is used narrowly, excluding the 14 British Overseas Territories and Crown Dependencies (Jersey, Guernsey and the Isle of Man).

² The total area covered by these zones is hereafter referred to as 'UK waters'.

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The remainder of the paper is organised as follows: [Section 2](#) contains contextual information – it outlines relevant spatial and functional characteristics of the UK's offshore jurisdiction, and briefly examines the legal basis for offshore CO₂ storage under international and European law. [Section 3](#) identifies key design features of the UK Marine and Coastal Access Act 2009 (MCAA), Energy Act 2008, Petroleum Act 1998, Crown Estate Act 1961, and associated relevant policy measures. [Section 4](#) discusses the interaction of specific components of the UK's framework for marine permitting and planning. It also appraises the extent to which this interaction facilitates orderly development of offshore CO₂ storage in the context of UK policy objectives regarding commercial deployment of CCS. [Section 5](#) concludes by highlighting features of the UK's approach to planning and regulation of offshore CO₂ storage (and its interaction with other marine activities) that may be of particular interest to other countries and jurisdictions.

2. Offshore jurisdiction of the UK and legal basis for offshore CO₂ storage

2.1. Designated maritime zones

The UK acceded to the 1982 Law of the Sea Convention (LOSC) [9] on 25 July 1997 [10] and has designated maritime zones of national jurisdiction that correspond generally to the requirements set out in that Convention (see [Fig. 2](#)). The Territorial Sea Act 1987 and associated Statutory Instruments establish a territorial sea that extends 12 nautical miles seaward from the designated UK baseline, apart from in the Straits of Dover where the seaward limit follows the course of a maritime boundary between the UK and France [11]. Statutory Instruments issued under the Continental Shelf Act 1964 designate areas beyond the territorial sea within which the UK Government may exercise 'any rights exercisable by the United Kingdom... with respect to the sea bed and subsoil and their natural resources' [12]. In most locations, the seaward limits of these continental shelf areas are defined pursuant to bilateral maritime boundary agreements between the UK and: Belgium, Denmark, France, Germany, Ireland, the Netherlands and Norway [13]. Designated continental shelf areas in the Celtic Sea, Bay of Biscay, and Hatton Rockall area of the Northeast Atlantic extend more than 200 nautical miles from baseline, and overlap partially with continental shelf areas declared by neighbouring States (i.e. Denmark and Iceland in Hatton Rockall area; France, Ireland and Spain in the Celtic Sea and Bay of Biscay).³ The Marine and Coastal Access Act 2009 provides for the designation of an Exclusive Economic Zone (EEZ) in which UK may exercise the package of rights recognised in LOSC Part V (concerning the EEZ) [14]. The UK Government has not yet designated an EEZ, but has announced its intention to do so following final determination of the boundaries of the zone and negotiations with neighbouring States [15]. At present the UK adopts a sectorally fragmented approach to enabling the exercise, under domestic law, of the EEZ rights recognised in LOSC Part V: The UK Government has designated several overlaying maritime zones that each extend beyond the territorial sea up to a maximum of 200 nautical miles

from baseline. In each of these zones the UK exercises a functional subset of its EEZ rights. The relevant zones (and corresponding enabling legislation) are the: area within British Fishery Limits (Fishery Limits Act 1976 section 1); Renewable Energy Zone (Energy Act 2004 section 84); Pollution Zone (The Merchant Shipping (Prevention of Pollution) (Law of the Sea Convention) Order 1996 article 2); Gas Importation and Storage Zone (Energy Act 2008 section 1).

2.2. Devolved jurisdiction within maritime zones

In several locations and for certain matters, the offshore jurisdiction of the United Kingdom has been devolved to the constituent countries of Northern Ireland, Scotland and Wales. The devolution of jurisdiction to these entities is complex, and will not be analysed comprehensively in this paper. For the present purposes it is however relevant to note the following: Scotland, Northern Ireland and Wales are allocated, respectively, certain devolved functions within defined maritime zones (the 'Scottish Zone' [16], 'Northern Ireland Zone' [17] and 'Welsh Zone' [18]). Each of these zones is subdivided into an 'inshore region' (the waters of each zone enclosed by territorial sea limits) and 'offshore region' (the waters of each zone located beyond the territorial sea and enclosed by British Fishery Limits).⁴ Within each of these subzones, different components of the UK's maritime jurisdiction are devolved to the relevant constituent country. Specific examples of devolved jurisdiction concerning marine planning and offshore CO₂ storage are discussed in [Sections 3 and 4](#) of this paper.

2.3. Legal basis for offshore CO₂ storage under international and European law

Under international law, the UK has a clear (though not unqualified) conventional entitlement to regulate offshore CO₂ storage within its designated maritime zones. Within the UK's territorial sea, this entitlement flows from the recognition in LOSC article 2 of coastal State sovereignty over that zone. In relation to the EEZ and continental shelf, the entitlement to regulate offshore CO₂ storage flows from the recognition in the LOSC of certain sovereign rights and exclusive jurisdictional competencies within those zones. Concerning the EEZ, LOSC article 56 provides that a coastal State has:

'sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds' [19].

LOSC article 56 (as supplemented by other relevant provisions of the Convention) also specifically recognises the exclusive jurisdiction of a coastal State within the EEZ with regard to: '(i) the establishment and use of artificial islands, installations and structures; (ii) marine scientific research; (iii) the protection and preservation of the marine environment ...' [20]. Concerning the continental shelf, LOSC article 77 permits a coastal State to exercise 'sovereign rights for the purpose of exploring it and exploiting its natural resources.' [21]. This broad provision is supplemented by specific entitlements to exercise jurisdiction in relation to submarine cables and pipelines (LOSC article 79); artificial islands, installations and structures (LOSC article 80); and drilling (LOSC article 81) on the continental shelf. The conferrals of sovereign rights and jurisdiction mentioned above cover all activities associated with offshore CO₂ storage, including: marine scientific research to identify geological sites suitable for CO₂ storage; construction of pipelines to transport CO₂ to the storage site; and

³ The LOSC employs a complex set of requirements to determine the outer limits of a coastal State's continental shelf (see LOSC Part VI and Annex II). In order to establish a continental shelf limit that is located more than 200 nautical miles from baseline, LOSC States Parties are required to submit information to the Commission on the Limits of the Continental Shelf (CLCS), which considers the information and makes recommendations as to the relevant limit. Responding to a joint submission of Ireland, France, Spain and the UK, the CLCS has issued a recommendation concerning the outer limits of the continental shelf in the Celtic Sea and Bay of Biscay (see http://www.un.org/Depts/los/clcs_new/clcs_home.htm). At the time of writing, the Commission has yet to issue a recommendation responding to the UK's submission concerning the Hatton Rockall area.

⁴ MCAA Part 11 section 322, which also, for the purposes of spatial planning, subdivides English waters into an inshore and offshore region.

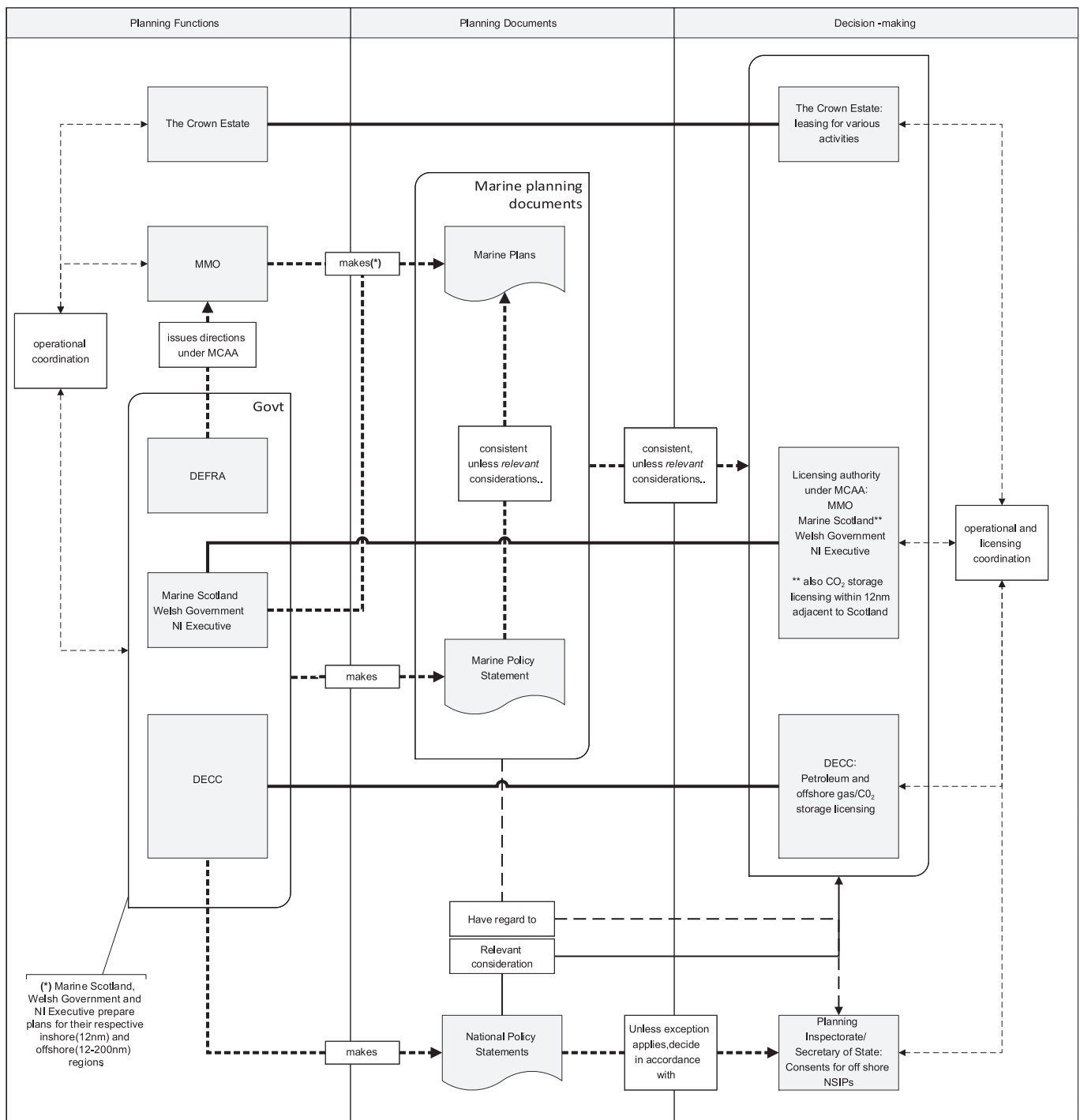


Fig. 1. UK Framework for marine permitting and planning.

injection of liquefied CO₂ into deep geological formations beneath the seabed (e.g. depleted oil and gas reservoirs, and deep saline aquifers) for the purpose of storing it there on a permanent basis.

The UK is party to several international instruments that prescribe to varying degrees the manner in which offshore CO₂ storage is to be regulated in UK waters. The key instruments in this context are: (1) 1972 London Dumping Convention [22], as amended by the 1996 London Protocol [23]; (2) 1992 OSPAR Convention [24] for the protection of the marine environment of the North East Atlantic; and (3) the 2009 EC Directive on Geological Storage of Carbon Dioxide (EU CCS Directive) [25], which applies to the UK as a consequence of its membership of the European Union.

The 1972 London Dumping Convention and subsequent Protocol establish a framework for managing the dumping of wastes and other matter at sea. The definition of 'dumping' in the 1996 London Protocol includes 'any storage of wastes or other matter in the seabed or subsoil thereof from vessels, aircraft, platforms or other man-made structures at sea' [26]. 'Wastes and other matter' are broadly defined as 'material and substance of any kind, form or description' [27]. The Protocol prohibits the dumping at sea of all substances except for those listed in its Annex 1. For the listed substances, a permit must be granted in accordance with detailed technical and environmental conditions set out in Annex 2 and associated guidelines. Following amendments agreed in November 2006, 'CO₂ streams' are included

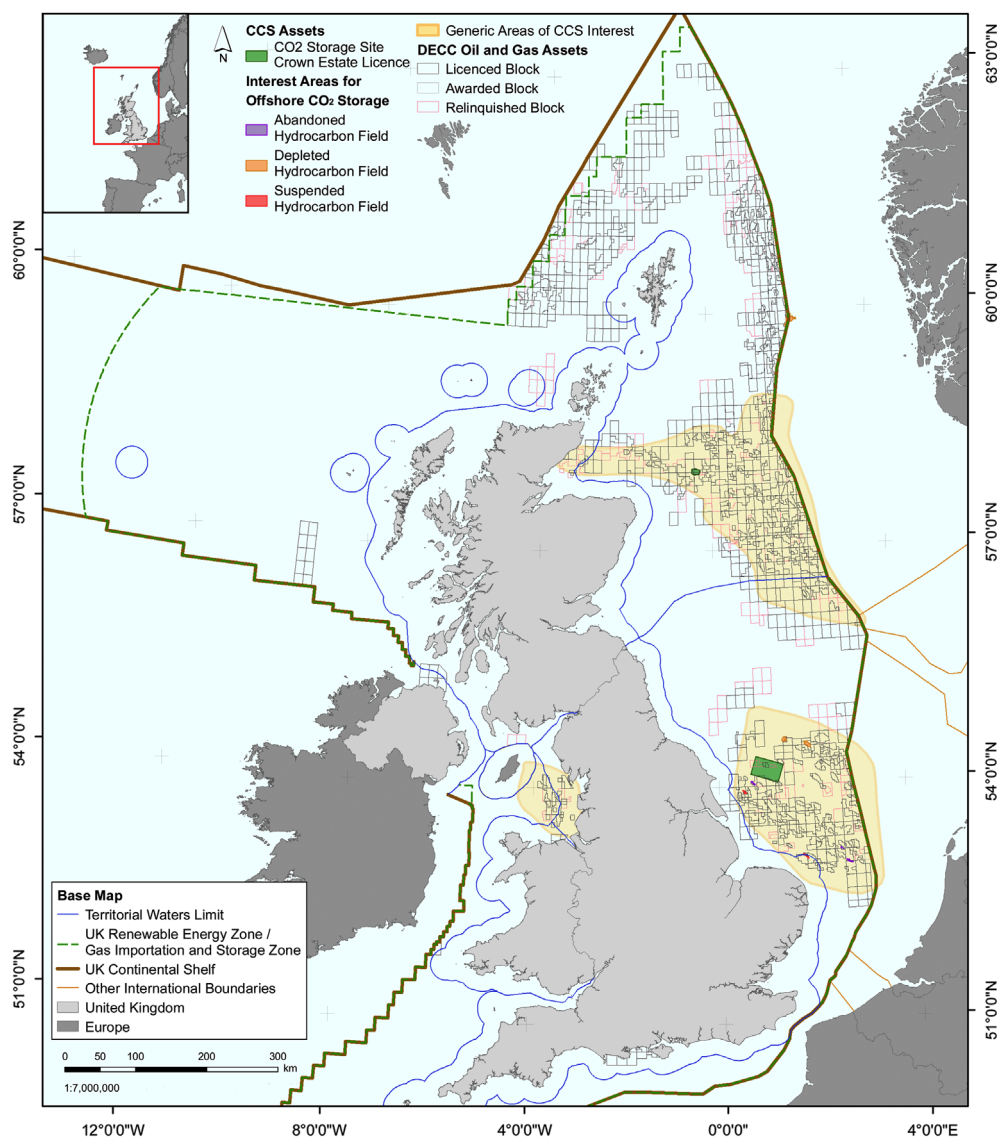


Fig. 2. UK maritime zones, CO₂ storage interest areas, and petroleum licence blocks.

in Annex 1, and may be disposed of provided that (1) the disposal is into a sub-seabed geological formation; (2) the stream consists overwhelmingly CO₂; and (3) no wastes or other matter are added for the purpose of their disposal [28].

The 1992 OSPAR Convention establishes a framework for managing the marine environment of the North East Atlantic region (excluding the Baltic and Mediterranean Seas) [29]. The Convention requires its Parties, inter alia, to 'take all possible steps to prevent and eliminate pollution' and 'take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems...' [30]. It contains detailed obligations concerning: environmental quality assessment (Annex IV of the Convention); protection and conservation of ecosystems and biological diversity (Annex V); and pollution arising from land-based sources (Annex I), dumping and incineration (Annex II), and offshore sources (Annex III). In 2007 States Parties to the Convention adopted, by consensus, several amendments designed to enable regulated offshore CO₂ storage activities. Annex II of the Convention was amended to specifically permit the dumping of CO₂ streams from CO₂ 'capture processes' subject to four conditions. The first three of these conditions are identical in substance to those found in the 1996 London Protocol. The fourth condition is considerably more restrictive – CO₂ streams must be 'intended to be retained' on a

permanent basis in sub-soil geological formations, and must not 'lead to significant adverse consequences for the marine environment, human health and other legitimate uses of the maritime area.' [31]. Annex III of the OSPAR Convention was also amended to enable, on the same conditions set out in Annex II, the dumping of CO₂ streams from offshore installations.

The EU CCS Directive establishes a detailed legal framework for the environmentally safe storage of CO₂ both onshore and offshore. The UK has implemented ('transposed') the Directive's provisions by modifying its pre-existing petroleum legislation and associated regulatory policies [32].

3. Key design features of the UK legal and policy framework

Existing UK legal and policy frameworks that impact on offshore CO₂ storage and planning for such activities fall into four broad clusters, which are discussed below:

3.1. Marine and Coastal Access Act 2009

This legislation was developed in order to consolidate regulation and planning of marine activities in UK waters, and implement in a

marine context the UK Government's commitment to sustainable development [33–37]. The Act's core provisions relate to: establishment of the Marine Management Organisation (MMO) (Part 1); designation of certain maritime zones (Part 2); marine planning and licensing (Parts 3 and 4); nature conservation including the designation of marine conservation zones (Part 5); inshore and offshore fisheries management (Parts 6 and 7); law enforcement (Part 8); and recreational coastal access (Part 9).

The foundation of the Act's marine planning and licensing framework is a 'Marine Policy Statement', in which the UK Government and other participating government bodies publish general policies 'for contributing to the achievement of sustainable development' in UK waters [38]. The current (and first) Marine Policy Statement was published in March 2011 and was prepared jointly by the UK Government, Northern Ireland Executive, Scottish Government and Welsh Assembly Government [39]. The statement contains several paragraphs that highlight the importance of offshore CO₂ storage, and planning for such activities, as means of implementing the UK's legal and policy commitments concerning climate change mitigation [40].

The MCAA subdivides UK waters into eight 'marine planning regions' which correspond to the inshore and offshore regions of England, Northern Ireland, Scotland and Wales [41]. The Act does not establish a planning framework for the inshore regions of Northern Ireland and Scotland, reflecting a devolution of legislative responsibility to those constituent countries [42]. For each of the remaining six planning regions (or parts thereof), the Act provides for the preparation of a 'Marine Plan' by designated government bodies [43]. The list of designated bodies includes the MMO, which operates autonomously from the UK Government, but is required to comply with directions issued under with MCAA section 37 by the Secretary of State (i.e. cabinet minister) in charge of the UK Department of Environment, Food and Rural Affairs (DEFRA).

At present, responsibility for preparing Marine Plans is allocated as follows – English inshore and offshore regions: MMO; Scottish offshore region: Marine Scotland; Welsh inshore and offshore regions: the Welsh Government; Northern Ireland offshore region: Department of the Environment in Northern Ireland. As of December 2013, Marine Plan preparation for several locations is nearing completion. Draft Marine Plans for Scotland, and selected English waters in the North Sea, were released for consultation in July 2013 [44,45]. The MMO commenced Marine Plan preparations for selected waters in the English Channel in early 2013 [44].

The MCAA requires Marine Plans to be 'in conformity' with the Marine Policy Statement unless 'relevant considerations indicate otherwise' [46]. Each plan must identify (using a map or other means) the area in which it applies, and state the relevant government body's policies for the sustainable development of that area [46]. The March 2011 Marine Policy Statement notes that Marine Plans should, as far as possible, cover the full range of marine activities and accommodate new uses of the marine environment [47].

The MCAA also establishes a marine licensing system [48], which applies to a broad range of marine activities [49]. Different components of the system are administered by the MMO and relevant government bodies in Northern Ireland, Scotland and Wales [50]. For certain offshore 'nationally significant infrastructure projects' (NSIPs) defined under the Planning Act 2008 (i.e. large harbour facilities and electricity generating stations with a capacity > 100 MW), the marine licence is issued automatically ('deemed') as part of a 'development consent order' issued by the relevant Secretary of State [51,52]. The relevant Secretary of State issues such orders after receiving advice from the Planning Inspectorate, which reviews planning applications for NSIPs taking

into account relevant 'National Policy Statements' [53]. Key Statements in the present context are the Overarching Energy National Policy Statement and Renewable Energy Infrastructure National Policy Statement [54], both of which are developed by the UK Department of Energy and Climate Change (DECC).

Critically for the present purposes, the MCAA exempts from the requirement to obtain a marine licence certain activities concerning oil and gas development and offshore CO₂ storage [55]. Such activities are instead licensable under the Energy Act 2008 or Petroleum Act 1998 (see Sections 3.2 and 3.3 below). All public authorities in the UK are required to take any authorisation or enforcement decisions in accordance with the Marine Policy Statement and relevant Marine Plan, unless 'relevant considerations indicate otherwise.' [56]. Where such decisions are not taken in accordance with the Marine Policy Statement and relevant Marine Plan, the relevant public authority is required to state its reasons [57].

3.2. Energy Act 2008

This legislation reformed many and various aspects of energy infrastructure and market regulation in the UK [58–60]. Part 1 of the Act contains provisions regarding the regulation of natural gas and CO₂ storage (and various associated activities) in the UK territorial sea and Gas Importation and Storage Zone. Such activities may only be undertaken in accordance with a licence granted by the Secretary of State in charge of DECC; or by the Scottish Ministers if proposed activities are located in the territorial sea adjacent to Scotland.⁵ These authorities may issue regulations concerning the terms and conditions associated with licences [61]. Subject to any issued regulations, a licence may be granted on such terms and conditions as the licensing authority considers appropriate [62]. The spatial limits of licensing areas in which CO₂ storage and associated activities are authorised may be determined by reference to a Crown Estate lease concerning such activities (see Section 3.4 below) [63].

A series of regulations [64–71] issued per Part 1 Chapter 3 of the Energy Act 2008 (and the European Communities Act 1972⁶) have prescribed detailed terms and conditions regarding the licensing of offshore CO₂ storage. They implement provisions of the EU CCS Directive, concerning inter alia: conditions for granting licences and exploration permits; the obligations of the relevant storage operator; the closure of the CO₂ storage site; the post-closure period; and financial security. Neither the EU CCS Directive, Energy Act 2008 or associated regulations contain detailed provisions concerning cross-sectoral marine planning. The Directive does however require competent UK authorities to (1) maintain registers of information concerning the spatial extent and location of authorised activities relating to CO₂ storage; and (2) take these into consideration during relevant planning procedures [72]. The Directive also prohibits, in very general terms, 'conflicting uses' of locations for which CO₂ storage or preparatory exploration activities are authorised [73]. In practice, the DECC manages potential conflicts in UK waters between offshore CO₂ storage and oil and gas operations by prioritising the latter: applications for CO₂ storage licences are refused if proposed operations threaten the 'overall security and integrity of any other activity in the vicinity or neighbouring area.' [74].

The regulatory framework established under Part 1 Chapter 3 of the Energy Act 2008 does not apply to the use of CO₂ for the purpose

⁵ Energy Act 2008 section 4; and 17–18, which also contain special provisions for licensable activities located only partly in Scottish territorial waters.

⁶ Section 2(2) of the European Communities Act 1972 enables, inter alia, designated UK government bodies to promulgate secondary legislation for the purpose of implementing the UK's obligations under European Union law.

of enhanced oil recovery (EOR)⁷ operations, unless DECC makes an order reversing that default position (for particular operations or generally) [75]. As far as the author is aware, no such order has been made to date. As a result, CO₂ storage as a consequence of EOR operations remains unregulated under the Energy Act 2008. Such activities are instead licensed and regulated under the Petroleum Act 1998 (see Section 3.3 below). The UK Government has also indicated that it will make orders applying the Energy Act 2008 to any EOR operators who intend to claim credits under the EU Emissions Trading Scheme for CO₂ stored [76].

3.3. Petroleum Act 1998

This legislation was developed in order to consolidate and reform regulation of submarine pipelines and the oil and gas industry in the UK [77]. The Acts core provisions relate to: petroleum exploration and exploitation (Part 1); application of civil and criminal law to activities associated with offshore installations (Part 2); submarine pipelines (Part 3); and abandonment of offshore installations, including offshore installations used in connection with CO₂ storage (Part 4).

The Act enables, *inter alia*, the DECC to issue various forms of licences to 'search, bore for and get' petroleum in the UK territorial sea and continental shelf [78]. It also enables the DECC to authorise in writing the construction and use of submarine pipelines in those maritime zones [79]. DECC is required to make regulations concerning the: procedures, requirements and fees associated with petroleum licence applications; conditions regarding the size and shape of areas in respect of which petroleum licences may be granted; and 'Model Clauses' that, unless specifically excluded in a particular case, are incorporated into petroleum licences [80]. The model clauses (and other regulations) allow DECC to control a wide range of matters including specific aspects of: offshore construction; provision of information; environment, health and safety precautions; surrender of licensed areas that are not being exploited; unitisation of petroleum deposits; and various commercial terms on which petroleum development is undertaken [81].

The Petroleum Act 1998 and associated regulations do not contain detailed provisions concerning CO₂ storage. However, as noted previously, the Act does provide a detailed basis for regulating these activities to the extent that they are used to 'get' petroleum during EOR operations.

There is also an absence in the Act of detailed provisions concerning cross-sectoral marine planning. The prevailing practice in the UK has been to open up two-dimensional seabed blocks for licensing in a series of rounds (27 to date), influenced primarily by economic considerations (see Fig. 2) [82]. Potential planning conflicts between petroleum development and other activities are managed through a general prioritisation of the former: The March 2011 Marine Policy Statement notes that a policy objective of the UK is 'to maximise economic development of the UK's oil and gas resources reflecting their importance to the UK's economic prosperity and security of energy supply' [83]. DECC is however expressly permitted, when exercising functions under the Petroleum Act 1998, to 'have regard' to various matters including: activities relating to electricity generation (e.g. offshore wind farms) in the UK territorial sea or Renewable Energy Zone; activities licensed under Part 1 Chapter 2 the Energy Act 2008 relating to gas importation and storage; and activities licensed under Part 1 Chapter 3 of the Energy Act 2008 relating to CO₂ storage

[84]. There are also several provisions designed to minimise potential conflicts between offshore petroleum development and certain other established industries. The current Model Clauses prohibit petroleum licensees from undertaking authorised operations 'in such a manner as to interfere unjustifiably with navigation or fishing in the waters of the Licensed Area or with the conservation of the living resources of the sea.' [85]. They also require the Licensee to maintain a relationship with local fishing industries [86]. Note also Petroleum Act 1987 sections 21, 23 and 24, establishing 500 m safety zones around oil and gas installations, and, per Energy Act 2008 section 32, around installations used for CO₂ storage.

3.4. Crown Estate Act 1961

The Crown Estate is a large property portfolio that is owned by the reigning monarch 'in right of the Crown', and is managed by an independent statutory corporation referred to as the Crown Estate Commissioners [87]. Surplus revenue generated by the Crown Estate is paid to the UK Treasury [88]. The Crown Estate Act 1961 sets out the powers and duties of the Commissioners, prescribing in general terms the manner in which the Estate is to be managed [89]. The basic duty of the Commissioners in relation to the Estate is to 'maintain and enhance its value and the return obtained from it, but with due regard to the requirements of good management.' [90].

The Crown Estate has a significant offshore component, which includes: almost all of the seabed within the UK territorial sea limit; in addition to the UK's sovereign rights over the continental shelf (except in relation to oil, gas and coal), Renewable Energy Zone, and Gas Importation and Storage Zone [91]. Consequently, in addition to satisfying applicable regulatory requirements, offshore CO₂ storage licensable by DECC under the Energy Act 2008 (and broad range of other offshore activities) must also be authorised by a lease or licence agreement between the relevant developer and the Crown Estate Commissioners.

The Crown Estate Commissioners must take into account their statutory duty to maintain and enhance the value of a cross-sectoral portfolio of property interests, and therefore have an incentive to minimise conflict between different offshore activities. In practice, a variety of spatial planning considerations and proximity checks are taken into account before decisions are taken to grant seabed rights via a lease or licence to prospective offshore developers [92]. Conditions designed to minimise conflicting offshore activities are also integrated into standard lease and licence agreements. For example: in their standard lease concerning offshore CO₂ storage the Commissioners' retain a right of termination for lease areas (or part thereof) for which 'oil and gas works' are authorised under the Petroleum Act 1998 [93]. The Crown Estate Commissioners have also entered into a memorandum of understanding with the MMO, in which both organisations pledge to share certain information concerning their respective activities, and 'work closely together ... in areas of mutual interest', including marine planning [94].

Acting with a view to enhancing the prospective value of the Crown Estate's offshore CO₂ storage rights, the Commissioners are undertaking a significant research and development programme regarding CCS [95]. The programme includes collaborations with the commercial sector in the form of a CCS Cost Reduction Task Force, and development of a CO₂-storage geospatial database in partnership with the British Geological Survey [95].

4. Component interactions and scope for orderly deployment of offshore CO₂ storage

The review undertaken in Section 3 illustrates that offshore CO₂ storage (and other human uses of the marine environment) in the UK are planned for and regulated under a complex patchwork of

⁷ EOR refers to a variety of techniques for increasing the amount of crude oil that can be extracted from an oil field. Injection of CO₂ into a geological formation containing oil is at present the most common method of EOR. See Advanced Resources International. Global Technology Roadmap for CCS in Industry: Sectoral Assessment of CO₂ Enhanced Oil Recovery. United Nations Industrial Development Organization: May 5 2011. Available at: <www.globalccsinstitute.com/publications/> .

sectorally fragmented laws, and by different public bodies. Fig. 1 presents a diagrammatic representation of (1) key components of the UK's framework for marine permitting and planning, and (2) key interactions between these components. Key components and interactions are explained where relevant below.

There are two key public bodies within which decisions are made to authorise offshore CO₂ storage and associated activities:

- DECC – Issues licences under Petroleum Act 1998 covering CO₂ storage undertaken as part of EOR projects not claiming credits under the EU Emissions Trading Scheme. Issues licences under Energy Act 2008 covering all other CO₂ storage activities.
- Crown Estate Commissioners – Grants leases or licence agreements, required for CO₂ storage activities licensable by DECC under the Energy Act 2008.

There are four key bodies within which planning, and/or authorisation decisions, are undertaken in relation to marine activities that may spatially compete or conflict with offshore CO₂ storage development:

- Crown Estate Commissioners – Undertakes spatial planning to inform grant of leases and licences for offshore components of the Crown Estate (e.g. for offshore CO₂ storage, natural gas storage, submarine cables, wave and tidal energy generation, offshore wind farms, etc).
- Major Infrastructure Planning Unit – Issues development consent orders in relation to large harbour facilities and electricity generating stations > 100 MW.
- Bodies designated by the MCAA – Develop Marine Plans in accordance with the Marine Policy Statement, and issue licences in relation to marine activities generally.
- DECC – Develops key National Energy Policy Statements. Determines the manner in which offshore acreage is released for petroleum development (including CO₂ storage associated with EOR operations). Issues licences for such activities, and for natural gas storage and CO₂ storage.

To what extent is the UK's complex and sectorally fragmented framework for marine permitting and planning capable of delivering the overarching policy objective to achieve commercial deployment of CCS in the 2020s? Regulatory complexity and fragmentation are often characterised as having adverse consequences for marine policy delivery (and environmental governance more generally) at national, regional and international scales. Commonly cited adverse consequences include: inefficient decision-making; high transaction costs; inconsistent or contradictory regulatory standards; and conflicting uses of the marine environment [96–100]. Investor confidence in new, capital-intensive activities such as offshore CO₂ storage and CCS is particularly sensitive to these types of regulatory risk.

The risks associated with regulatory complexity and sectoral fragmentation can be mitigated through implementation of measures that enable different components of a regulatory framework to operate in a coherent, coordinated manner. When such measures are present, complexity and sectoral fragmentation may yield beneficial outcomes including: inclusive decision-making, improved institutional memory, diversification of risk, and systemic resilience [101–103]. The UK framework for marine permitting and planning contains a diverse array of measures designed to exert a coordinating influence on its component rules and decision-making bodies. Key coordinating measures are outlined below:

4.1. Hierarchical coordination through Policy Statements and Marine Plans

As noted previously, the Marine Policy Statement and associated Marine Plans influence decision-making by all relevant

public bodies, who are required to either take them into account ('have regard to' in the case of the Planning Inspectorate) [104,105] or act consistently with them 'unless relevant considerations indicate otherwise' (in the case of the other public bodies). Subject to several exceptions set out in the Planning Act 2008 (section 104) decisions by the Planning Inspectorate/Secretary of State concerning offshore NSIPs must also be taken in accordance with relevant National Policy Statements.

The 'relevant considerations' exception referred to above is broadly framed and rather unclear [106]. It does however have a close equivalent in UK terrestrial planning law, namely the 'unless material considerations indicate otherwise' exception which is subject to a large body of judicial clarification and interpretation [107]. In any event, the requirement to state reasons justifying departures from marine planning documents represents as a significant political disincentive to un-coordinated decision-making. The exception also maintains consistency between the National Policy Statements and the Marine Policy Statement, because provisions of the former can be characterised as 'relevant considerations' which justify permitting decisions that depart from the latter.

4.2. Coordination through 'carve-outs' in permitting requirements

Several marine permitting requirements contain exceptions designed to minimise duplication and sectoral overlaps. Key examples referred to in Section 3 above include the: omission from the MCAA marine licensing framework of offshore CO₂ storage activities licensed under the Energy Act 2008 and Petroleum Act 1998; policy under the Energy Act 2008 of refusing applications for CO₂ storage licences that potentially conflict with oil and gas operations; linkage under the Energy Act 2008 between CO₂ storage licence areas and the boundaries of corresponding Crown Estate leases/licences; power of the Secretary of State under the Petroleum Act 1998 to 'have regard' to various matters including offshore windfarms and CO₂ storage; Petroleum Act 1998 Model Clauses addressing potential conflicts with fishing and navigation; and rights retained by the Crown Estate Commissioners to terminate leases in areas where oil and gas works are authorised under the Petroleum Act 1998.

4.3. Non-hierarchical operational coordination

In the manner depicted in Fig. 1, public bodies also communicate actively with each other on an informal basis with a view to coordinating their respective activities concerning marine permitting and planning. Information sharing and marine planning cooperation between the Crown Estate Commissioners and MMO has also been partially formalised via the MoU signed by both bodies.

There remains a risk that, despite the coordinating measures surveyed in Sections 4.1–4.3 above, the UK's offshore planning framework is inclined to producing spatial allocations that are orderly, but not conducive to fulfilment of the overarching policy objective to achieve large scale commercial deployment of CO₂ storage in the 2020s. Two key factors that contribute to this risk are discussed below:

4.4. Spatial coverage of petroleum licences and prioritisation of petroleum development

After 27 licensing rounds, large areas of the UK continental shelf are already subject to petroleum licences issued under the Petroleum Act 1998. Most identified interest areas for CO₂ storage are also subject to petroleum licences (see Fig. 2). Oil and gas production in North Sea UK waters is expected to continue until at least 2040, with remaining recoverable reserve estimates ranging between 11.9–25 billion BOE [108].

DECC's current policy is to refuse applications for CO₂ Storage Licences if proposed operations threaten the overall security and integrity of any other activity (including licensed petroleum operations) [109]. The onus is placed on applicants for CO₂ storage licences to clearly demonstrate the absence of these threats, or preferably obtain the consent of the relevant incumbent licensee [109]. Notwithstanding its economic or other merits, this cautious approach to licensing (non-EOR) CO₂ storage activities that are co-located with, or proximate to, petroleum licence blocks limits the spatial opportunity for such activities to the extent that CO₂ storage and petroleum development are proposed or undertaken by different commercial entities who are unable or unwilling to establish a contractual relationship. This challenge has quickly presented itself in the southern North Sea, where the second licence agreement granted by the Crown Estate to a prospective CO₂ storage developer (National Grid) [95] overlaps partially with petroleum licence blocks granted to other commercial entities (see Fig. 2).

4.5. Content of Marine Policy Statement and Marine Plans

The Marine Policy Statement does not currently contain clear objectives and/or planning presumptions concerning offshore CO₂ storage. This calls into question whether sufficient space for (capital-intensive and long-timescale) CO₂ storage activities will be retained as UK waters become increasingly crowded with other infrastructure. The Marine Policy Statement does highlight the importance of offshore CO₂ storage as means of implementing the UK's legal and policy commitments concerning climate change mitigation [110]. However, in contrast to clearer priorities for other sectors (e.g. the objective to 'maximise economic development' of oil and gas), decision-makers are only required in very general terms 'to consider' and 'take into account' opportunities for offshore CO₂ storage and related policy commitments [110].

It appears likely that Marine Plans developed to supplement the Marine Policy Statement will reduce uncertainty regarding the spatial opportunities available for offshore CO₂ storage. The current MMO draft marine plan for selected English waters in the North Sea [111] designates 'areas of potential' for CO₂ storage, in which marine licence applicants:

'should demonstrate in order of preference:

- (a) that they will not, wherever possible, prevent carbon dioxide storage
- (b) how, if there are impacts on carbon dioxide storage, they will minimise or mitigate these
- (c) the case for proceeding with the proposal if it is not possible to minimise or mitigate the impacts'.

An equivalent policy is notably absent from the Consultation Draft of Scotland's National Marine Plan, which sets out clear objectives to develop CO₂ storage, but does not identify in detail how this objectives is to be reconciled with clear objectives to develop a wide range of other marine activities (e.g. marine renewable energy) [108]. It does however contemplate the preservation of spatial opportunity for CCTS projects by requiring that 'Consideration should be given to the development of marine utility corridors which will allow [CCTS] to capitalise on current infrastructure in the North Sea including shared use of spatial corridors and pipelines.' [108].

5. Features of particular interest to other countries and jurisdictions

The UK's approach to planning and regulation of offshore CO₂ storage (and its interaction with other marine activities) is illustrative

of three key points that may be of particular interest to other countries and jurisdictions:

First, how a diverse array of coordination measures can be used to promote coherence within a complex and sectorally fragmented regulatory framework. As highlighted in Section 4 above, coherence can be promoted hierarchically (e.g. legal requirements to act consistently with certain policy instruments); or non-hierarchically (e.g. operational coordination arrangements; careful scope delineation of sector-specific permitting requirements). A distinctive feature of the UK's approach is the cross-sectoral planning activity undertaken by the Crown Estate Commissioners, acting their capacity as a public but non-governmental owner of a broad portfolio of offshore property interests. As far as the author is aware, the Commissioners' cross-sectoral marine management and planning functions, exercised at arms length from government,⁸ do not have an equivalent in any other country or jurisdiction.

Second, coherent cross-sectoral planning and regulation of marine activities can be promoted with limited centralisation of regulatory frameworks and associated government agencies. As noted in Section 4 above, decentralisation may yield beneficial outcomes provided coherence is maintained, including: inclusive decision-making, improved institutional memory, diversification of risk, and systemic resilience.

Finally, a coherent planning framework may be necessary but not sufficient to deliver on high-level policy objectives to deploy offshore CO₂ storage. The UK's experience highlights a risk that, without specific planning objectives and spatial allocations, spatial opportunity for offshore CO₂ storage may be limited by incumbent sectors.

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